



# **Human Factors Engineering Assessment of the TeamMATE System for Dismounted Embedded Training and Mission Rehearsal**

**by Bryan R. Clark, Dean E. Reed, Jessie Y.C. Chen, and Henry A. Marshall**

**ARL-TR-4479**

**June 2008**

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## Contents

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<b>List of Figures</b>	<b>v</b>
<b>Acknowledgments</b>	<b>vi</b>
<b>1. Introduction</b>	<b>1</b>
1.1 Purpose .....	1
1.2 Background .....	1
<b>2. Method</b>	<b>5</b>
<b>3. Results</b>	<b>5</b>
3.1 General Recommendations.....	5
3.1.1 Menu Buttons (figure 6) .....	6
3.1.2 On-screen Keyboard (figure 7).....	7
3.1.3 “Plan” Symbols (figure 8) .....	7
3.1.4 Undo .....	8
3.1.5 Tabbed Horizontal Menu Layouts (figure 9) .....	9
3.1.6 Default Tools (figure 10).....	10
3.1.7 Save and Trash Functions (figure 11) .....	10
3.1.8 Populating Drop-Down Menus (figure 12) .....	11
3.1.9 Consistent Labeling (figure 13).....	12
3.1.10 Expandable Drop-Down Menus (figure 14).....	13
3.1.11 Quitting a Task (figure 15).....	14
3.1.12 Sketching Tab (figure 16).....	15
3.1.13 Help Menu .....	15
3.2 “Plan” Task Recommendations.....	15
3.2.1 Menu Defaults (figure 17).....	15
3.3 “Rehearse” Task Recommendations .....	16
3.3.1 Menu Defaults (figure 18).....	16
3.3.2 Entity Selection in “With a Plan” Mode (figure 19) .....	17
3.3.3 Plan Detail Language (figure 20) .....	18
3.3.4 Health Bar (figure 21) .....	19
3.3.5 Weapon Range Indicator (figure 22).....	20
3.3.6 Map Zoom .....	20

3.4	“Execute” Task Recommendations .....	20
3.4.1	Menu Defaults .....	21
3.4.2	Entity Selection in “With a Plan” Mode .....	21
3.5	“Review” Task Recommendations.....	21
3.5.1	Menu Defaults (figure 23).....	21
3.5.2	Leader Versus Non-Leader Selection (figure 24) .....	22
3.5.3	Synchronizing With Others .....	22
<b>4.</b>	<b>Conclusions</b>	<b>23</b>
<b>5.</b>	<b>References</b>	<b>24</b>
	<b>Appendix A. Usability Heuristics</b>	<b>25</b>
	<b>Glossary of Acronyms</b>	<b>27</b>
	<b>Distribution List</b>	<b>28</b>

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## List of Figures

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Figure 1. The TeamMATE hardware.....	2
Figure 2. The TeamMATE software on the Dell Axim.....	2
Figure 3. TeamMATE opening menu.....	3
Figure 4. TeamMATE planning mode screen.....	3
Figure 5. C2MINCS application with STEP.....	4
Figure 6. TeamMATE menu buttons.....	6
Figure 7. On-screen keyboard.....	7
Figure 8. “Plan” symbols.....	8
Figure 9. Tabbed horizontal menu layouts.....	9
Figure 10. Default tools.....	10
Figure 11. Save and trash functions.....	11
Figure 12. Populating drop-down menus.....	12
Figure 13. Consistent labeling.....	13
Figure 14. Expandable drop-down menus.....	13
Figure 15. Quitting a task.....	14
Figure 16. Sketching tab.....	15
Figure 17. Menu defaults - plan task.....	16
Figure 18. Menu defaults - rehearse task.....	17
Figure 19. Entity selection in “with a plan” mode.....	17
Figure 20. Plan detail language.....	18
Figure 21. Health bar.....	19
Figure 22. Weapon range indicator.....	20
Figure 23. Menu defaults - review task.....	21
Figure 24. Leader versus non-leader selection.....	22

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Henry Marshall is now with the U.S. Department of Homeland Security.



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## 1. Introduction

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### 1.1 Purpose

In the past, the effectiveness of computer-supported embedded training (ET) devices for dismounted Soldiers (DS) is often compromised because of their costs on a per-unit basis and other constraints such as power and weight. New, highly technical combat unit experiments such as Future Warrior (FW) Integration (formerly Future Force Warrior) and Land Warrior (LW) systems seek to provide the DS with a computational platform. However, several key performance parameters of ET are not yet available in these products. TeamMATE (Team Mission Assistant-Tactical/Exercise), developed under the Scalable Embedded Training-Mission Rehearsal (SET-MR) Army Technology Objective (ATO) of the U.S. Army Research, Development, and Engineering Command's Simulation and Training Technology Center, is a computer application that promotes tactical awareness and provides many desirable ET functions to the DS. The U.S. Army Research Laboratory performed a human factors engineering (HFE) assessment on TeamMATE and this report documented this assessment effort.

### 1.2 Background

TeamMATE was developed in response to the need of a very low cost solution to ET for the individual Soldier. The hardware platform for TeamMATE is a Dell Axim<sup>1</sup> 51v personal digital assistant (PDA). The Axim is augmented with an external battery (for a longer operational lifetime) and a Global Positioning System receiver for real-time spatial awareness (figure 1). The total cost of the commercial off-the-shelf equipment for TeamMATE tallies to less than \$550 per unit and presents a very reasonable per-unit cost, even when compared to a Multiple Integrated Laser Engagement System (MILES). The Axim also supports an on-board three-dimensional graphics accelerator, which is rarely found on business class PDA systems (see figure 2).

TeamMATE supports four modes: plan, rehearse, execute, and review (figure 3). The planning mode (figure 4) allows a team leader to formulate a plan for distribution to his or her team. The planning mode supports a phase-based system for introducing and explaining a mission. The team leader can share his plan with the squad and can unfold the plan as he explains the individual phases. Objectives, way points, fields of fire, and rally points are all supported within the TeamMATE planning phase.

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<sup>1</sup>Dell and Axim are trademarks of Dell Corporation.



Figure 1. The TeamMATE hardware.



Figure 2. The TeamMATE software on the Dell Axim.

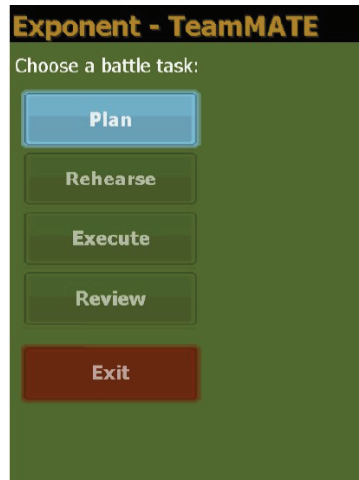


Figure 3. TeamMATE opening menu.

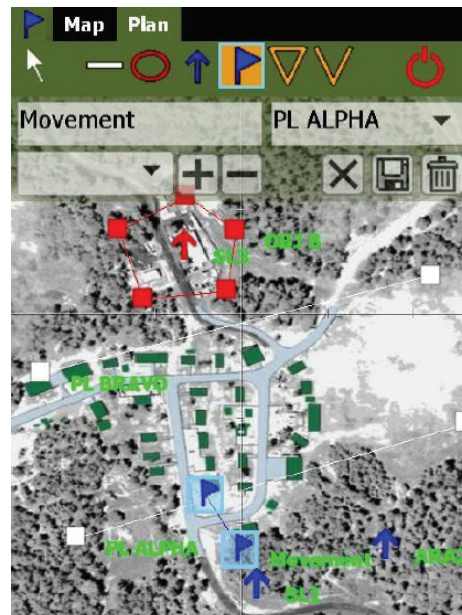


Figure 4. TeamMATE planning mode screen.

The Rehearse mode supports the ability to virtually practice a mission designed during the planning phase. Rehearse mode also allows the virtual force-on-force engagement, capabilities to “puckster” (i.e., role play) multiple entities, as well as white boarding for map markup<sup>2</sup>. The Execute mode is provided to actually perform the missions outside (e.g., a military operations on urban terrain exercise). TeamMATE uses a recording method to keep track of player positions and optional MILES hit/miss data. The Review mode allows users to replay exercise data collected in the Rehearse or Execute modes. Video cassette recorder-like software controls and an event graph indicate important exercise events to the user.

<sup>2</sup>That is, multiple users can draw on the same map.

Since Windows<sup>3</sup> was the operating system (OS) for TeamMATE, it could not be transitioned to programs such as FW or LW, which use Linux<sup>4</sup> as their host OS. Therefore, the SET-MR ATO needed a new transition strategy to move the TeamMATE functionality into these FW/LW programs. The new transition strategy derived was to re-implement the TeamMATE functions on the host platform with the use of a plug-in architecture. This concept is called the Soldiers' Training Enhancement Package (STEP) and involves employing the host software such as the command and control mobile intelligent net-centric computer system (C2MINCS) on the FW platform to realize a subset of the TeamMATE functions (figure 5). Isolating the appropriate functions and presenting them correctly to the user required HFE evaluations, which are presented in the following section.

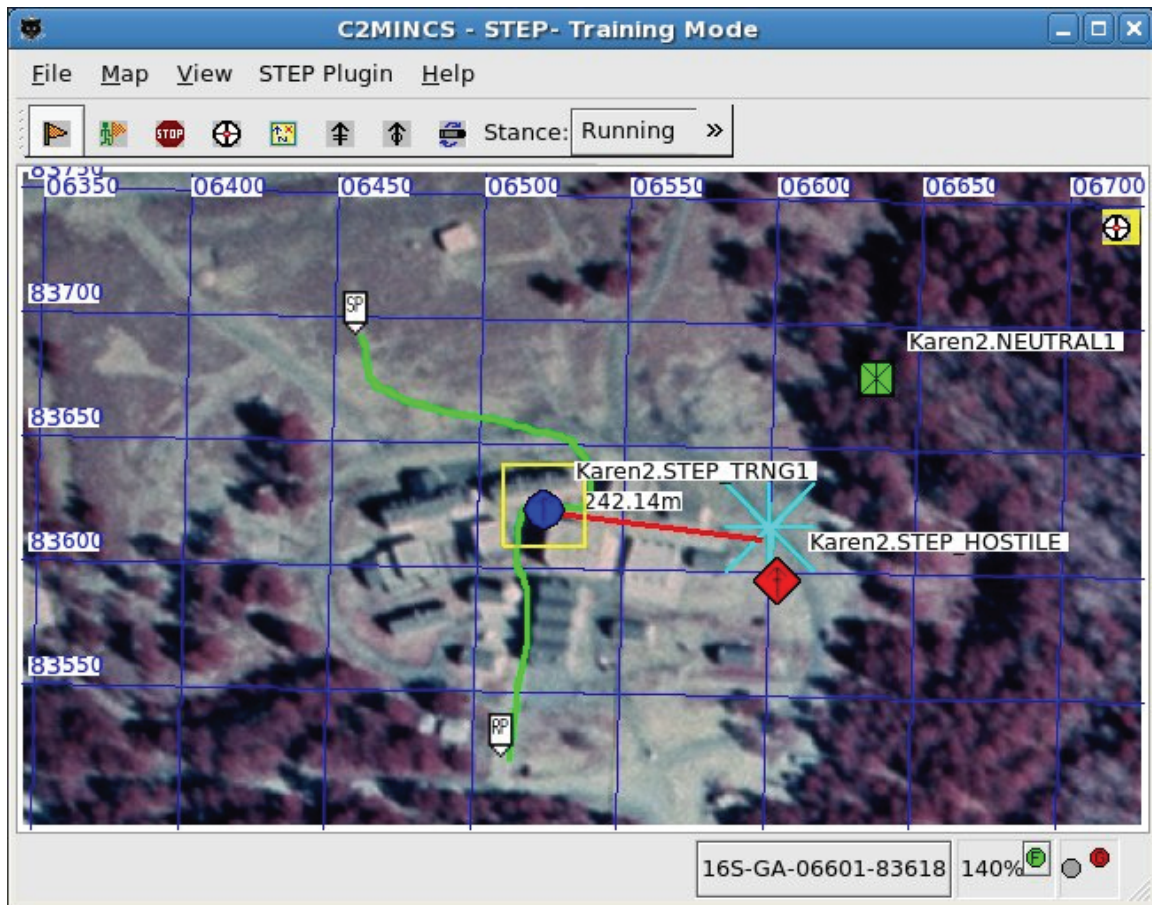


Figure 5. C2MINCS application with STEP.

<sup>3</sup>Windows is a registered trademark of Microsoft Corporation.

<sup>4</sup>Linux is a registered trademark of Linus Torvalds.

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## 2. Method

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A heuristic/expert evaluation for usability was performed on the TeamMATE user interface. Specifically, the following tasks were conducted:

- (a) Collecting background information: The background information examined includes
  - *Context of use and intended user:* TeamMATE is a mission rehearsal and planning tool for the team leader and his/her team members.
  - *Environmental factors:* Stress (psychological and temporal) can be potentially involved.
  - *Screen size:* The screen size on the PDA is a critical factor for the interface design since it limits the number of buttons that can be displayed to the user. In the case of the Dell Axim 51v, the maximum resolution is 480x640 and is a limiting factor on the user interface design.
  - *Network:* TeamMATE works with a larger networked system including multiple TeamMATE hand-held devices.
- (b) Heuristic Evaluation for Usability: The list of heuristics by Jakob Nielsen (2007) was used for the HFE assessment ([http://www.useit.com/papers/heuristic/heuristic\\_list.html](http://www.useit.com/papers/heuristic/heuristic_list.html); see appendix A). Each feature of TeamMATE was tested, thus ensuring that it did not violate any usability heuristics, while we kept in mind the context of use and network-ability of the system as appropriate.

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## 3. Results

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This section describes recommendations for improving the usability of the TeamMATE system interface. There are five parts in this section, each containing its own prioritized list of usability issues and recommendations. The highest priority recommendation is listed first; thus, the lowest priority recommendation is listed last in each section. The General Recommendations (3.1) apply to the entire system (including all four Task modes), so they should be given priority over the task-specific recommendations.

### 3.1 General Recommendations

The following recommended changes impact the general layout, functionality, and navigation of the TeamMATE system software. These recommendations should be given higher priority over the task-specific recommendations because of their effect on the entire system.

### 3.1.1 Menu Buttons (figure 6)

*Recommended Changes:* Make all selectable buttons blue by default (before user selects one). When the user taps on a button with the stylus, the background color of the button selected should change to gray (not black).

- To enhance this further, make the button blink twice (blue-gray-blue-gray) and remain gray as it transitions to the next screen.
- See also, *General Recommendation 3.1.9 regarding Consistent Labeling*, in terms of the “Exit” button in the Main Menu.



Figure 6. TeamMATE menu buttons.

*Impact on usability:* This will improve visibility of all buttons and will add the missing user feedback, which will reduce confusion resulting from the current inconsistent use of color.

Example: Currently, there are cases when one button is blue but the others are gray, such as in the main menu where the top button, “Plan Task,” is blue but the other tasks are gray, and exit is red.

Although the intention of coloring the “Plan” button blue may have been an attempt to guide the user (under the assumption that “Plan” is the first task most users will use), this may only be helpful to first-time users. Also, because a user may turn on the program and use any of the four tasks (out of sequence from their menu position), it is best to have them all colored the same. Since “Plan” is the first in the list, this should be a sufficient subtle “guide” to first-time users, even without different colors. Most important is providing user feedback to show that the software is working after a button has been selected (e.g., blinking the button colors). Without this feedback, the user may treat it like an elevator button and tap it multiple times, assuming that it did not work the first time.

- The only exception to this rule may be the “Exit” button in the main menu because it is separated from the four main tasks physically (spaced apart) and functionally. It can remain red, but when it is selected, it should blink twice (between gray and red) to provide user feedback that it has been selected.

### 3.1.2 On-screen Keyboard (figure 7)

*Recommended Changes:* Sometimes the keyboard launches automatically and covers buttons toward the bottom of the screen. For example, when one is creating a new Plan, the “Start” and “Cancel” buttons are mostly obscured by the on-screen keyboard, which often launches when the screen is first displayed.

- Option 1 (Best): The keyboard should only be launched manually (i.e., when the user taps on the keyboard icon at the bottom of the screen).
- Option 2: The buttons should be moved higher above the keyboard (though this may be impossible on some screens) so the buttons are unobscured.

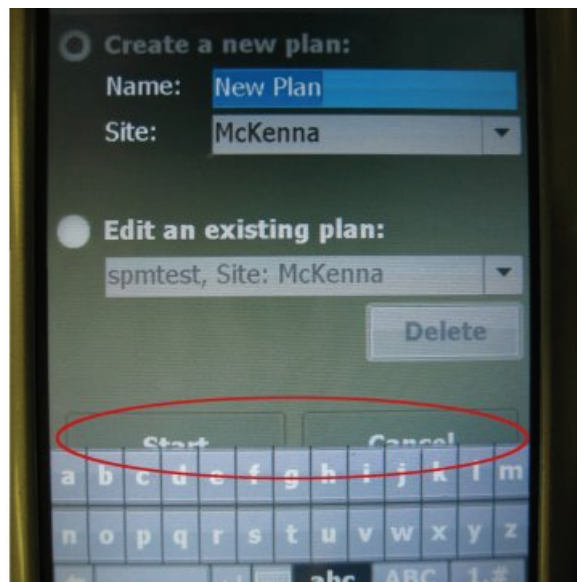


Figure 7. On-screen keyboard.

*Impact on usability:* This will enhance visibility of the interface and prevent confusion when the user cannot see the buttons and does not know what to do next to continue.

### 3.1.3 “Plan” Symbols (figure 8)

*Recommended Changes:* When one is planning a mission, the lines related to objects/tools (e.g., the phase line, objective lines, lines between flags, etc.) are very difficult to see. Increasing the weight of the lines to be at least double their current weight will increase their visibility. Note



that these Plan symbols are available in more than one task (not just the Plan Task), which is why it is listed as a General Recommendation.

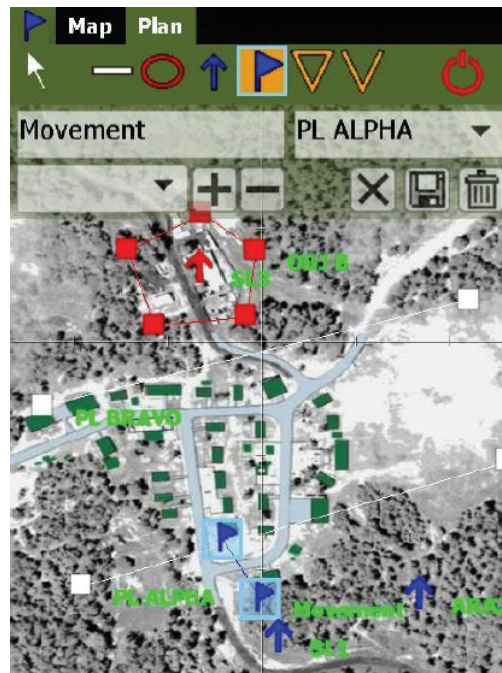


Figure 8. “Plan” symbols.

*Impact on usability:* Especially for users who require corrective vision or have imperfect vision, increasing the line weights for all on-screen planning objects will improve usability by making them easier to find, which will also improve efficiency.

### 3.1.4 Undo

*Recommended Changes:* No “Undo” function is available if a user makes an error and wishes to correct it.

- This tool should be accessible on every horizontal menu tab toolbar where it can be used.

*Impact on usability:* Adding an “Undo” function will improve usability by providing users the freedom to correct their errors easily and confidently. Without it, the user must develop a strategy for resolving the problem.

- One example of this is the placement of movement flags in the Plan Task. After the user starts placing flags on the screen, the flags are connected. The user cannot delete or undo the last flag placed if an error is made and must discard all or none of the flags. After the user selects “Save,” a new set of flags can be created that are not connected to the previously set flags.



- If it fits, spell out “Undo”. An alternative may be a popularized icon for Undo or something similar, such as a “Back” button (used in web browsers and on backspace keys on a keyboard).
- The “Undo” function should be consistently located in all system tasks (e.g., it may always be positioned to the left of the “Quit” icon). It should be on every tab (in every task) that may require its use, such as the “Plan,” “Sketching,” and “Rehearsal” tabs.

### 3.1.5 Tabbed Horizontal Menu Layouts (figure 9)

*Recommended Changes:* When one is entering a task (Plan, Rehearse, Execute, or Review), the horizontal menus should be arranged so that the selected task is the right-most tab label. Currently, “Plan” is the right-most tab in each task, and if the user wishes to quit that task, it is not evident by that starting screen; the user must navigate to the tab with the name of the selected task to find the “Quit” button.

- When a user is entering a new task (e.g., “Rehearse” Task), the right-most tab should be the selected task label (in this case, “Rehearse,” not “Plan” as it currently is), and it should be the one that is selected by default.
- The remaining tabs should be organized consistently:
  - Tab 1 = Map
  - Tab 2 = Sketching
  - Tab 3 = Plan
  - Tab 4 = Selected Task (default highlighted)
- Note: in the Plan Task, there is no “Sketching” tab, so the Selected Task (“Plan”) would be Tab 2 in this case.



Figure 9. Tabbed horizontal menu layouts.

*Impact on usability:* This adds consistency to menu navigation and should improve user efficiency and trust with system behaviors.

### 3.1.6 Default Tools (figure 10)

*Recommended Changes:* When one is entering one of the four system tasks (Plan, Rehearse, Execute, Review), the left-most object/tool in the toolbar should be highlighted. Presently, this is inconsistent, and in some cases, nothing is highlighted or a tool in the middle is highlighted.

- Also, any time the user switches to a new tab, the left-most tool/icon should be highlighted (orange background surrounded by a blue box).
- For detailed changes, see task-specific recommendations.

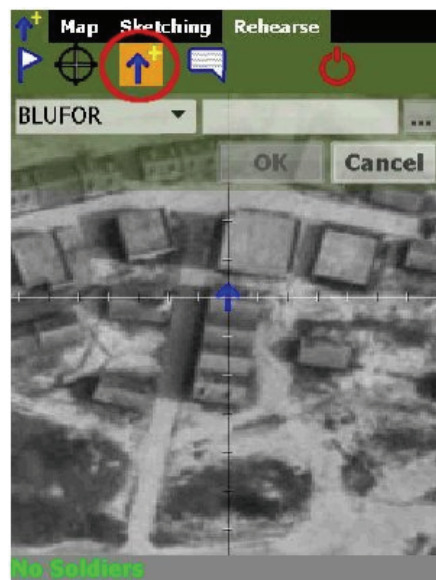


Figure 10. Default tools.

*Impact on usability:* An interface's consistency of appearance and functionality is vital to a user's confidence and trust as it relates to system interactions.

- Highlighting the “default” tool can also be employed to discreetly guide the user's initial interaction with each system task.

### 3.1.7 Save and Trash Functions (figure 11)

*Recommended Changes:* To the novice user, the use of these icons may not be obvious, partially because they do not attract the user's attention, and the user may continue without tapping the “Save” icon and still be able to continue. There are a couple possible solutions to improve usability of these icons:

- After the Save and Trash icons are appropriate to use (e.g., the user has used a tool and placed that tool's object on the screen, such as a phase line or flag movement markers), the Save icon should change color, indicating that it should be selected. Furthermore, it may flash (slowly, like the "Play" icon in Review Task) to call the user's attention.
- An alternative, which may also be used redundantly with the previous step, is to display an error message when the user has placed an object on the screen (e.g., a phase line) and attempts to proceed to select a different tool or menu tab without tapping the "Save" icon. In this case, a message such as "Tap Save" or "Delete to Continue" would be appropriate to inform the user that this is necessary to continue.



Figure 11. Save and trash functions.

*Impact on usability:* Because the Save icon appears to be unnecessary in some cases (e.g., the system automatically saves the placement of some tools), it appears inconsistent to the user. This will eventually disrupt the user's mental model relative to how that function works and when it is necessary to use.

The consistency of a system's appearance and behaviors is vital to a user's ability to develop an appropriate and accurate mental model of the system. Anything contrary to this mental model will lead to user doubts and distrust of the system, which will manifest as "user errors" and/or user frustration.

### 3.1.8 Populating Drop-Down Menus (figure 12)

*Recommended Changes:* There are a few instances when the user must associate an entity (or entities) with a selected tool, such as movement flags, phase lines, etc. An empty drop-down menu appears next to plus and minus boxes when the user selects the tool. Rather than requiring

the user to tap through several layers of menus to find each entity, this should be simplified so that all selectable entities are visible, without the user having to expand submenus.



Figure 12. Populating drop-down menus.

*Impact on usability:* There are a few ways this may be done. One way is to make it more graphical, with large icons for each team, almost like a hierarchical organization chart. Alternatively, if it remains text based, the drop-down menu should at least be automatically populated with the menus expanded to reveal the selectable entities (which is based on those previously selected—in Plan Task, for example).

### 3.1.9 Consistent Labeling (figure 13)

*Recommended Changes:* In the Main Menu, if the user wishes to stop using TeamMATE, tapping the word “Exit” will close the program. When one is using any of the four tasks, however, the message box displayed uses the term “Quit” rather than “Exit”. One term should be consistently used throughout the system.

- “Quit” is more common, especially when associated with the boxed “X” icon, and is used most throughout the TeamMATE system, with the exception of the Main Menu. The label in the Main Menu should be changed from “Exit” to “Quit” to provide consistency of labeling.

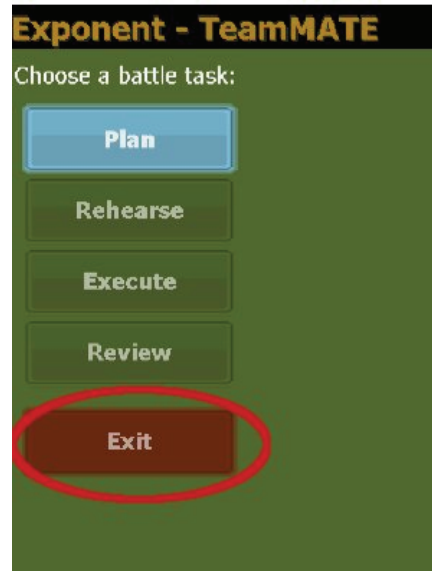


Figure 13. Consistent labeling.

*Impact on usability:* Consistency throughout a system improves usability and efficiency, especially in terms of the user's mental model of system behaviors.

### 3.1.10 Expandable Drop-Down Menus (figure 14)

*Recommended Changes:* Currently, the user must tap the stylus on the arrows next to menu items in a drop-down box in order to expand or collapse a submenu. The user should also be able to tap on the name label next to the arrow for redundancy.



Figure 14. Expandable drop-down menus.

*Impact on usability:* In human factors literature, Fitts' Law (Fitts, 1954) states that a user's efficiency (in terms of time and accuracy) may be increased with larger selectable targets and shorter travel distances (e.g., moving a computer mouse across the screen). This is one reason why Windows icons, as well as the text labels below them, are selectable with a mouse. On a PDA, there is no "mouse" movement, so tapping with a stylus is direct and generally a short distance; thus, the size of "tap-able" areas on the screen becomes most important to improving user efficiency. In TeamMATE, there are several instances when the user must tap several levels deep into a menu in order to select an entity. Usability and efficiency can be improved if the user is able to use the stylus to select the name labels next to the arrows (in addition to the arrows) to expand or collapse a menu. See also *Populating Drop-down menus* (3.1.8).

### 3.1.11 Quitting a Task (figure 15)

*Recommended Changes:* When one is using one of the system tasks (Plan, Rehearse, etc.), in order to quit that task, s/he currently must tap on a symbol that represents the international "Power symbol". This does not immediately connote "Exit" or "Quit," so a more easily recognizable symbol should be used to communicate this.

- It would also be useful to the user to display a message saying something like, "All changes have been saved."

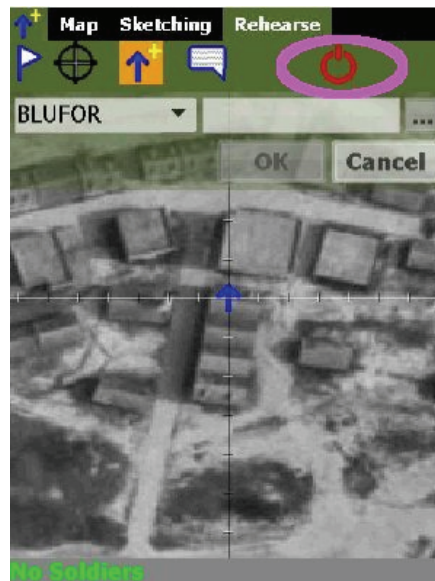


Figure 15. Quitting a task.

*Impact on usability:* The most recognizable symbol for "Quit" is an "X" surrounded by a box. Using this symbol will improve communication to the user, thus reducing uncertainty.

- Currently, it is not apparent that the system has saved all user changes when the user quits a task. This may not be necessary in all tasks, just the ones where the user adds content (and should be saving as s/he continues) such as Plan Task.



### 3.1.12 Sketching Tab (figure 16)

*Recommended Changes:* Add tool tips to Sketching tool icons. The functionality of the “clock” tool is not apparent, for example.



Figure 16. Sketching tab.

*Impact on usability:* Adding tool tips to the Sketching tool icons can prevent user errors and confusion.

### 3.1.13 Help Menu

*Recommended Changes:* Add a Help feature (tab) to every task’s menu in the software.

*Impact on usability:* A software “Help” feature will alleviate user frustration and prevent user errors.

## 3.2 “Plan” Task Recommendations

The following recommendations apply only to Plan Task, in addition to any changes listed in the *General Recommendations* section.

### 3.2.1 Menu Defaults (figure 17)

*Recommended Changes:* Remove the box outline around the “Map” tab. The “Plan” tab should be selected when the user enters Plan Task. The left-most icon on the Plan tab should be highlighted (i.e., box around it).

Note: Currently, the “Selection” tool is correctly highlighted (i.e., orange background), but the blue box outline is missing around it, so the outline around the “Map” tab needs to be removed and placed around the highlighted “Selection” tool.



Figure 17. Menu defaults - plan task.

*Impact on usability:* Consistency across all system tasks improves usability and efficiency.

### 3.3 “Rehearse” Task Recommendations

The following recommendations apply only to Rehearse Task, in addition to any changes listed in the *General Recommendations* section.

#### 3.3.1 Menu Defaults (figure 18)

*Recommended Changes:* Remove the box outline around the “Rehearse” tab.

Note: Currently, it depends on whether “Run a mission without a plan” or “with a plan” is selected as to what is highlighted when Rehearse Task is entered.

- a) “Without a Plan” The Rehearse tab is correctly selected, but the blue box surrounding the word “Rehearse” should be removed. Also, the “Add Entity” tool is highlighted (orange, but lacking a blue box). If this is the first thing the user needs to use in the Rehearse Task “without a plan,” it should be the left-most tool icon and should be highlighted (orange) with a blue box outlining it.
- b) “With a Plan” The left-most icon on the Rehearse tab should be highlighted (i.e., orange, with a blue box outlining it). Presently, nothing is highlighted.



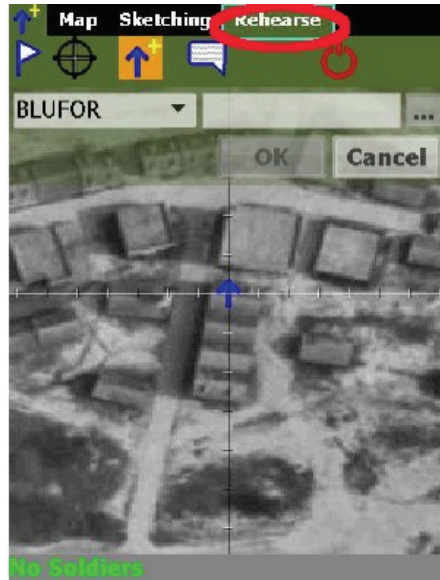


Figure 18. Menu defaults - rehearse task.

*Impact on usability:* Consistency across all system tasks improves usability and efficiency.

### 3.3.2 Entity Selection in “With a Plan” Mode (figure 19)

*Recommended Changes:* The interface for adding and removing entities for a mission rehearsal is not completely obvious. To improve the usability of this feature, remove the plus and minus buttons to the right of the entity selection text box, as well as the “(Available)” labels next to each entity name.

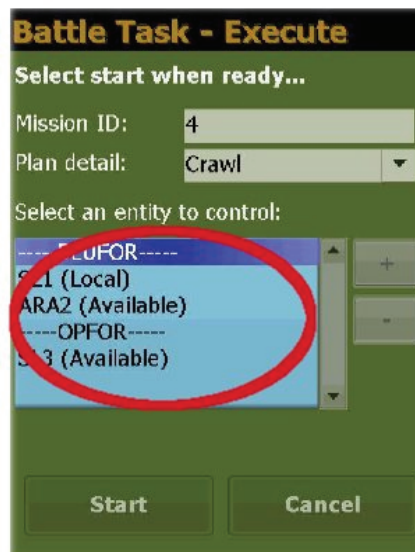


Figure 19. Entity selection in “with a plan” mode

Note: if necessary for user feedback, keep the “Local” and “External” labels (or just the “External” labels since “Local” may be implied by the “x” in the checkbox of a selected entity). Instead, display a list of “available” entities by placing a checkbox to the left of each entity name. If the user selects an entity, place an “x” in the checkbox. After the total number of possible entities has been selected, the names of the unselected entities should be “grayed” and italicized to show that they cannot be selected. To change a selected entity, tap on the selected entity’s checkbox (or name label – see Fitt’s Law in General Recommendation 3.1.10) and the “x” will be removed, changing all grayed entities to black, non-italicized labels. Depending on the number of potential entities from which to select, it may be necessary to place this list of entity names with their checkboxes inside a scrollable box.

*Impact on usability:* Whenever possible, it is best to use familiar user interactions since they require less instruction and will lead to fewer errors than a novel, unfamiliar user interaction, which may be less intuitive, especially for novice users of a system.

### 3.3.3 Plan Detail Language (figure 20)

*Recommended Changes:* It is not obvious what the difference is between “Crawl, Walk, and Run” labels in the Plan Detail selection box. This is not a strong metaphor for this feature because the labels may be interpreted in more than one way and this is a novel use for such a label.

- Change Crawl, Walk, Run to more simplified label names that are easily interpretable to a novice user. For example, for “Crawl,” which displays all mission plan detail, “All” would be an appropriate label. Thus, relabeling the names to be the following (or something along these lines) would make more sense:
  - Crawl = “All”
  - Walk = “Some”
  - Run = “None”

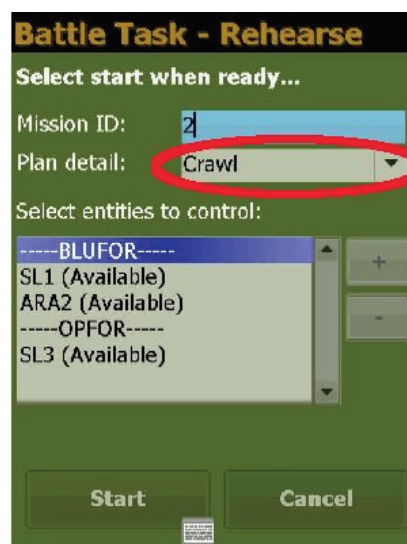


Figure 20. Plan detail language.

*Impact on usability:* It is always important to “speak the user’s language”. Metaphors and symbols/icons should be carefully used to ensure that they are highly recognizable (which may be a cultural issue) and require little or no instruction for what they do. Novice users will experience the most confusion/frustration with uncommon/unclear labels and language used in system messages, leading them to abandon the system (“give up”), seek printed or electronic “Help” in order to proceed, or fail to use the feature correctly, which may lead to even bigger problems as they proceed.

### 3.3.4 Health Bar (figure 21)

*Recommended Changes:* It may not be obvious that the green bar in the bottom right of the screen is the entity’s “health”. To make this more obvious, place an icon (such as a heart, which has been popularized by video games) next to the health bar. To prevent having too many icons next to one another, the icon may be placed to the left or to the right of the health bar. It should be the same color as the health bar (green, currently) and placed close to the health bar (if to the left of it, it should be spaced closer to the health bar than the icons to its left). Additional, (perhaps selectable) entity icons (such as the posture and selected weapon of the entity) should remain to the left of the health bar and be spaced at least twice the distance from the health bar icon as the health bar icon is spaced to the left of the health bar itself. In other words, if the health bar icon (e.g., a heart) is spaced 5 pixels to the left of the health bar, the next closest icon to the left of the heart should be spaced at least 10 pixels away.

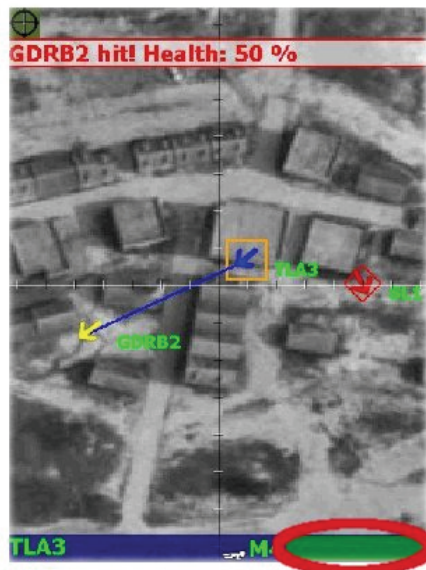


Figure 21. Health bar.

*Impact on usability:* Unfamiliar objects on the screen may be interpreted incorrectly, especially by novice users, if they do not have labels. To prevent user confusion, use recognizable icons whenever possible and label features that may not be completely obvious to the user. By spacing the health bar icon close to the health bar and then spacing additional icons a farther distance to the left of the health bar icon, Gestalt perceptual grouping principles will help the user determine

what is related or belongs together on the screen. This adds to the user's mental model, which is constantly changing as the user learns new system features.

### 3.3.5 Weapon Range Indicator (figure 22)

*Recommended Changes:* Weapon ranges should be consistently indicated with a circle (whose weight should be increased, see 3.1.3) that shows the maximum range. Currently, this is present for some weapons, such as grenades, but not others such as the M4.

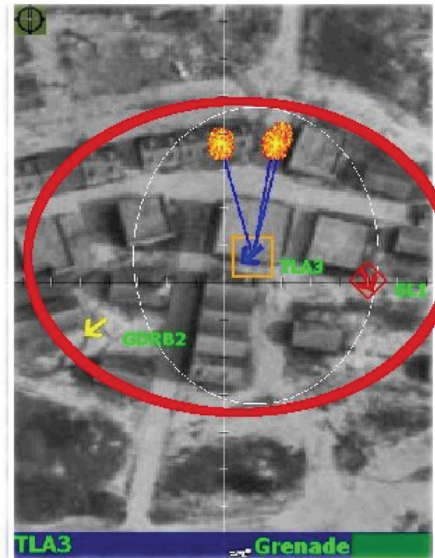


Figure 22. Weapon range indicator.

*Impact on usability:* Consistency will improve usability and understanding of the system.

### 3.3.6 Map Zoom

*Recommended Changes:* Consider adding a “Zoom to Fit” feature so that the user can view the map with ALL entities’ locations displayed.

*Impact on usability:* In some cases when several entities are spread across the map, the entity icons may be too small for a user to see in detail until zoomed in, but this will give the user a reference point to improve navigation.

## 3.4 “Execute” Task Recommendations

The following recommendations apply only to Execute Task, in addition to any changes listed in the *General Recommendations* section.

### 3.4.1 Menu Defaults

*Recommended Changes:* Remove the box outline around the “Map” tab. The “Execute” tab should be selected when the user enters Execute Task. The left-most icon on the Execute tab should be highlighted (i.e., box around it).

*Impact on usability:* Consistency across all system tasks improves usability and efficiency.

### 3.4.2 Entity Selection in “With a Plan” Mode

*Recommended Changes:* See same topic in Rehearse Task 3.3.2.

*Impact on usability:* See same topic in Rehearse Task 3.3.2.

## 3.5 “Review” Task Recommendations

The following recommendations apply only to Review Task, in addition to any changes listed in the General Recommendations section.

### 3.5.1 Menu Defaults (figure 23)

*Recommended Changes:* Presently, “Timeline” is highlighted, but the left-most tool (“Play”) should be highlighted instead (in orange) with a blue box around it.

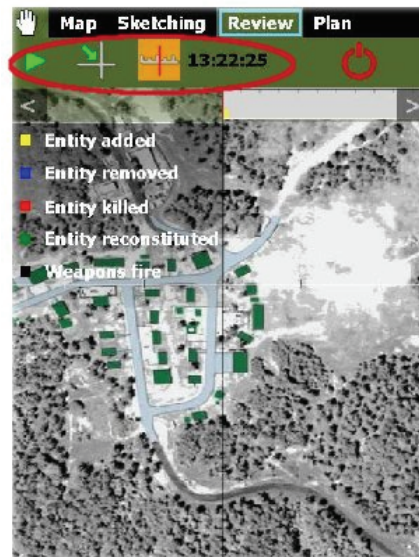


Figure 23. Menu defaults - review task.

*Impact on usability:* Consistency across all system tasks improves usability and efficiency.

### 3.5.2 Leader Versus Non-Leader Selection (figure 24)

*Recommended Changes:* This may be confusing to novices, especially since it is not clear if the “Leader” button means that one should press it to become the Leader or “is” selected as the Leader. Physical toggle buttons are permissible to use in this manner, but computer-based toggles are not always interpreted so easily. To eliminate any potential confusion, there should be two buttons side by side at the top of the screen:

- 1) Leader
- 2) Not Leader

It would also be good to put some sort of header or question to entice the user to select one (e.g., “Choose your role”). If it is assumed that the user will be the Leader most often, the Leader button can begin blue and the Not Leader button gray. Only one button at a time should be blue versus gray. When the user taps on a button, the screen below changes, displaying any other information or settings the user needs.

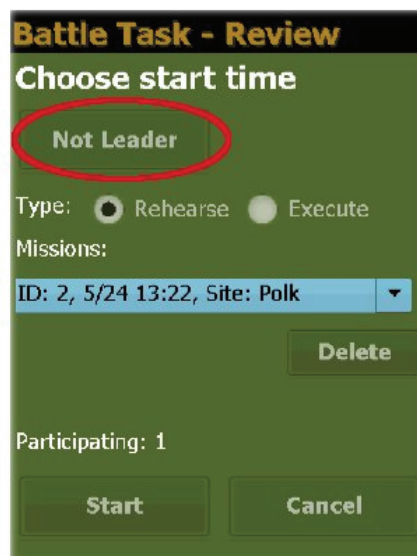


Figure 24. Leader versus non-leader selection.

*Impact on usability:* Feedback is important to usability of a system. If a user does not show both buttons and the status of each (by color), it may not be obvious that there are other selections that can be made (e.g., toggling between leader and non-leader in this case).

### 3.5.3 Synchronizing With Others

*Recommended Changes:* When several participants synchronize their devices, it is important that the local device ask the user if it may change the view per the originator’s request. User interruptions should be handled so they do not interrupt the user’s main task. A small, perhaps

semi-transparent text box asking “Synchronize with remote user?” with “yes/no” buttons is one way to do this.

Note: Because networked devices were not tested, this may not be a problem.

*Impact on usability:* It is always important to ask the user about changes that interrupt his or her primary task on a system.

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## 4. Conclusions

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In this report, we presented the usability analysis that we performed on the TeamMATE system and provided redesign recommendations. A brief study of TeamMATE was conducted as a student project at the West Point Military Academy under Dr. Ericka Rovira as part of an Engineering Psychology Class. The cadets studied the TeamMATE product and evaluated its usefulness (Grant, Zwick, & Fine, 2007). They reached a conclusion that using the TeamMATE product alone for retention of the mission information was slightly worse than the traditional sand table exercise. The analysis suggested that the user interface could be partially at fault and that improvements in the interface and iconology could result in TeamMATE being superior to traditional methods. This study also confirms suggestions in section 3 of this report with respect to issues such as improving consistency for icon usage (3.1.9) and the undo/redo capabilities (3.1.4).

As previously mentioned, the key functions of TeamMATE will transition to the STEP system and be an integral part of programs such as the Future Warrior Integration ATO. The analysis and recommendations presented in this report will continue to be used as a reference to improve the implementation of STEP. This assessment will be employed at each incremental and relevant integration checkpoint to improve the usability of the STEP user interface.

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## 5. References

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- Fitts, P. The information capacity of the human motor system in controlling the amplitude of movement. *Journal of Experimental Psychology* **1954**, 47, 381–391.
- Nielsen, J. (2007). Ten usability heuristics. Retrieved May 1, 2007 on [http://www.useit.com/papers/heuristic/heuristic\\_list.html](http://www.useit.com/papers/heuristic/heuristic_list.html).
- Grant, A.; Zwick, G.; Fine, K. *TeamMATE: A Virtual Sand Table*; unpublished manuscript; U.S. Military Academy: West Point, NY, 2007.



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## **Appendix A. Usability Heuristics**

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Ten Usability Heuristics (by Jakob Nielsen) [http://www.useit.com/papers/heuristic/heuristic\\_list.html](http://www.useit.com/papers/heuristic/heuristic_list.html)

These are ten general principles for user interface design. They are called “heuristics” because they are more in the nature of rules of thumb than specific usability guidelines.

### **Visibility of system status**

The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

### **Match between system and the real world**

The system should speak the users’ language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

### **User control and freedom**

Users often choose system functions by mistake and will need a clearly marked “emergency exit” to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

### **Consistency and standards**

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

### **Error prevention**

Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

### **Recognition rather than recall**

Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

### **Flexibility and efficiency of use**

Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

**Aesthetic and minimalist design**

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

**Help users recognize, diagnose, and recover from errors**

Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

**Help and documentation**

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

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## **Glossary of Acronyms**

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ATO	Army technology objective
C2MINCS	command and control mobile intelligent net-centric computer system
DS	dismounted Soldier
ET	embedded training
FW	Future Warrior
HFE	human factors engineering
LW	Land Warrior
MILES	Multiple Integrated Laser Engagement System
OS	operating system
PDA	personal digital assistant
SET-MR	Scalable Embedded Training- Mission Rehearsal
STEP	Soldiers' Training Enhancement Package
TeamMATE	Team Mission Assistant-Tactical/Exercise

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